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Application No.	:	10/707,469	Confirmation No. **1468**
Filing date:	:	December 16, 2003	
Applicant	:	Ramgopal Darolia et al.	
Art Unit:	:	1792	
Examiner	:	Elizabeth A. Burkhart	
Docket No.	:	13DV-14273	
Customer No.	:	30952	

Commissioner for Patents
P.O. Box 1450
Alexandria VA 22313-1450

AMENDED BRIEF UNDER 37 CFR §41.37(d)

This is an Amended Brief filed in response to a “Notice of Non-Compliant Appeal Brief” dated July 8, 2008, in which Appellants’ Appeal Brief filed June 13, 2008, was deemed to be non-compliant. Appellants hereby withdraw the non-compliant Appeal Brief in its entirety in favor of the present Amended Brief, which Appellants believe corrects all defects identified in the “Notice of Non-Compliant Appeal Brief.”

The requisite fee and other necessary charges for filing the non-compliant Appeal Brief were authorized against Deposit Account No. 08-0960. Appellants believe that no additional charges are due for filing the present Amended Brief.

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REAL PARTY IN INTEREST

The real party in interest is the General Electric Company, the assignee of record.

RELATED APPEALS AND INTERFERENCES

There are no prior or pending appeals, interferences, or judicial proceedings known to Appellants or Appellants’ assignee or Appellants’ representative that are related to, would directly affect or be directly affected by, or have a bearing on the Board’s decision in the pending appeal.

STATUS OF CLAIMS

Claims 1-32 were originally presented in this application. Claims 33-34 were introduced by an amendment filed August 16, 2007. Of these claims:

Claims 21-32 have been canceled;

Claims 1-20, 33 and 34 remain pending in the application, are rejected, and are the subject of this appeal.

STATUS OF AMENDMENTS

Following the final rejection, Appellants filed a response under 37 CFR §1.116, on February 18, 2008, without amendments to the claims. In an Advisory Action filed March 5, 2008 (Paper No. 20080225), the Examiner indicated that proposed amendments would not be entered for purposes of this appeal, even though no such amendments were proposed by Appellants.

SUMMARY OF CLAIMED SUBJECT MATTER

As stated at Paragraphs [0001] and [0006] of their specification (all paragraph numbers are in reference to the numbering assigned by the USPTO authoring software), Appellants’ invention is directed to a physical vapor deposition process for depositing ceramic coatings that contain multiple oxides and a carbon-based constituent (a carbon-based gas, elemental carbon, and/or carbides). A preferred aspect of the invention is to overcome the difficulty of depositing a coating having a desired and uniform composition when one or more of the multiple oxides has a vapor pressure significantly different than the other oxides. See Paragraphs [0004] (first two sentences) and [0008](first three sentences).

For the convenience of the Board, each independent claim involved in the appeal is reproduced below, with the reference numeral of each element as denoted in the specification and drawings set forth in parentheses, immediately followed by a concise explanation of the subject matter defined in the claim, referring to the specification by page and line number and to the drawings by reference characters.

> Claim 1: A process of depositing a ceramic coating **(16)** on a surface **(14)**, the ceramic coating **(16)** comprising multiple different oxide compounds and an oxide of a metal, the process comprising the steps of:
>
> using at least one evaporation source **(18,20)** to provide the oxide compounds and a carbide compound comprising carbon and the metal; and
>
> evaporating the at least one evaporation source **(18,20)** in the presence of oxygen to dissociate the metal from the carbide compound, oxidize the metal, and produce a vapor cloud that contacts and condenses on the surface **(14)** to form the ceramic coating **(16)**, the ceramic coating **(16)** comprising the oxide compounds, the oxide of the metal dissociated from the carbide compound, and at least one of elemental carbon, a carbon-containing gas, and precipitates of the carbide compound.

As recited in independent claim 1, a process is provided that forms a ceramic coating (16) by simultaneously deposits multiple oxides through the evaporation of at least one evaporation source (18,20) containing a carbide compound of a metal constituent of at least one of the desired oxides. See Paragraphs [0007] and [0014] (first two sentences). During evaporation, the metal dissociates from the carbide compound. See Paragraphs [0008] (fourth sentence) and [0014] (third sentence). The metal dissociated from the carbide is oxidized in the presence of sufficient oxygen, namely, oxygen levels above that necessary to ensure the deposition of the other oxides (which also dissociate during evaporation and therefore must reform during deposition).

See Paragraphs [0008] (fourth sentence) and [0017] (first sentence). The resulting vapor cloud is then able to contact and condense on the surface (14) to be coated, forming a coating (16) that contains the oxide of the metal dissociated from the carbide compound, as well as the other multiple oxides evaporated from the source. See Paragraphs [0007] and [0012] (second-to-last sentence). The carbon freed by dissociation of the carbide may deposit in the coating (16) in the form of a carbon-containing gas (CO or CO_2), elemental carbon, and/or carbide precipitates. See Paragraphs [0008] (last sentence), [0013] (second-to-last sentence), and [0014] (second-to-last sentence). The resulting coating (16) contains entrapped carbon-containing gases, and possibly elemental carbon and/or carbides in the form of precipitate clusters. See Paragraphs [0013] (second-to-last sentence) and [0019] (first two sentences).

In view of the foregoing, Appellants’ process recited in independent claim 1 requires the evaporation and dissociation of a carbide compound, and then the oxidation of metal atoms dissociated from the carbide compound, followed by deposition of the resulting metal oxide along with one or more carbon-based constituent dissociated from the carbide compound. From

Appellants' teachings, in order for the dissociated metal to oxidize and deposit as an oxide of the metal, dissociation must occur in the presence of oxygen levels exceeding that required to deposit the other oxide compounds.

> Claim 12: A process of depositing a thermal barrier coating **(16)** on a surface of a gas turbine engine component **(14)**, the thermal barrier coating **(16)** comprising yttria-stabilized zirconia and an oxide of a metal chosen from the group consisting of ytterbium, neodymium, lanthanum, and combinations thereof, the process comprising the steps of:
>
> placing the component **(14)** in a coating chamber **(12)** containing at least one ingot **(18,20)** that provides zirconia, yttria, and a carbide compound of the metal;
>
> projecting a high-energy beam **(28)** on the at least one ingot **(18,20)** in the presence of oxygen to melt the at least one ingot **(18,20)**, dissociate the metal from the carbide compound, oxidize the metal, and form a vapor cloud; and
>
> allowing the vapor cloud to contact and condense on the component **(14)** to form the ceramic coating **(16)**, the ceramic coating **(16)** comprising yttria-stabilized zirconia, the oxide formed by oxidation of ytterbium, neodymium, and/or lanthanum present as a result of dissociation of the carbide compound, and a uniform distribution of at least one of elemental carbon and CO.

From the above, it can be seen that independent claim 12 contains the limitations found in independent claim 1, along with the following additional limitations. The ceramic coating (16) is a thermal barrier coating, the surface (14) is on a gas turbine engine component (14), the multiple different oxide

compounds comprise yttria and zirconia (yttria-stabilized zirconia), the metal of the carbide compound and later oxidized is ytterbium, neodymium, and/or lanthanum, the evaporation source(s) (18,20) is/are ingot(s), and evaporation and dissociation are performed with a high-energy beam (28). See Paragraphs [0011] (first two sentences), [0012], [0013] (first sentence), and [0014] (first and second sentences), and Figure 1.

Furthermore, the coating (16) is required to contain “a uniform distribution of at least one of elemental carbon and CO.” See Paragraphs [0013] (second-to-last sentence) and [0019] (first two sentences).

GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL

A concise statement of each ground of rejection presented for review follows:

Whether Claims 1-20, 33, and 34 are patentable over the combination of U.S. Published Patent Application No. 2002/0172838 to Rigney et al. (the "Rigney Application," now issued as U.S. Patent No. 6,586,115) and U.S. Patent No. 6,492,038 to Rigney et al. (the "Rigney Patent") under 35 USC §103.

ARGUMENT

Rejection under 35 USC §103

Provided immediately below is a discussion of the scope and content of the prior art applied in the 35 USC §103 rejection of the claims under appeal, followed by remarks directed to the claims individually or grouped as set forth below.

Appellants respectfully traverse the 35 USC §103 rejection for the reason that their invention is an unobvious improvement over the prior art when evaluated under the criteria established by the Supreme Court in *Graham v. John Deere*, 148 U.S.P.Q. 459 (1966). As presented below, Appellants believe that the applied prior art does not teach or suggest a process for depositing a carbon-containing gas and an oxide of a metal by evaporating a carbide compound of the metal to dissociate atoms of carbon and the metal therefrom, and then oxidizing the dissociated metal atoms, followed by deposition of the carbon-containing gas and the oxide of the metal.

(1) <u>Scope and Content of the Prior Art</u>

<u>The Rigney Application, U.S. Patent Application 2002/0172838</u>

The Rigney Application discloses a coating material capable of exhibiting lower thermal conductivity than yttria-stabilized zirconia (YSZ) as a result of containing one or more additional metal oxides to increase crystallographic defects and lattice strain energy in the coating grains. Paragraph [0008] (sentence bridging pages 1 and 2). The additional metal oxides may be lanthana and/or neodymia. Table I at the end of Paragraph [0021]. The coating operation can be performed in a coating chamber that is backfilled with oxygen and an inert gas using coating source materials in ingot form, consistent with conventional EBPVD coating processes. Paragraph [0024] (first eighteen lines). Alternatively, the metal for the additional metal oxides may be introduced into the coating chamber as a metal vapor, which is then oxidized within the coating chamber. Paragraph [0024] (last twelve lines).

The Rigney Patent, U.S. Patent No. 6,492,038

The Rigney Patent discloses a method for depositing a coating material to contain extremely fine carbide-based and/or nitride-based precipitates. Abstract. Similar to the Rigney Application, the coating operation can be performed in a coating chamber that is backfilled with oxygen and an inert gas, consistent with conventional EBPVD coating processes. Column 5, Lines 30-37. The source of the carbide/nitride precipitates may be a carbon- or nitrogen-containing gas, which reacts to form the precipitates at defects and pores of the coating. Column 5, Lines 41-50. Alternatively, the source of carbon and/or nitrogen may be in ingot form. Column 5, Lines 56-58.

(2) Rejection of Claims 1-11 and 33 based on the Rigney Application and the Rigney Patent

Appellants' invention recited in independent claim 1 and its dependent claims 2-11 and 33 was concluded to be obvious in view of the combined teachings of the Rigney Application and Rigney Patent. However, neither teaches a coating process that entails (using the language of claim 1):

> using at least one evaporation source to provide the oxide compounds and a carbide compound comprising carbon and the metal; and
>
> evaporating the at least one evaporation source in the presence of oxygen to dissociate the metal from the carbide compound, oxidize the metal, and produce a vapor cloud that contacts and condenses on the surface to form the ceramic coating, the ceramic coating comprising…the oxide of the metal dissociated from the carbide compound….

In the Advisory Action of March 5, 2008, the Examiner acknowledged that

> the Rigney Patent ('038) does not disclose dissociating a metal atom from a carbide compound and oxidizing said metal atom, but simply vaporizing a carbide to deposit carbide precipitates along with YSZ.

The Examiner then concluded

> However, the Rigney Patent ('038) discloses that the ingot material may contain a carbide to deposit carbide precipitates along with YSZ…and the Rigney Application ('838) discloses that separate ingots of metal oxide and YSZ may be used to co-deposit a third oxide along with YSZ, wherein the metal oxide may also be formed by oxidizing a metal vapor [0024]. So while the Rigney Patent ('038) does not disclose providing an oxygen flow in excess of that required to simply reform YSZ which dissociates during electron beam evaporation, the Rigney Application ('838) does disclose providing a sufficient oxygen flow to oxidize metal source vapor to co-deposit a third metal

> oxide. Thus, the combination of the Rigney Patent (‘038) and the Rigney Application (‘838) would suggest supplying a sufficient amount of oxygen to oxidize a metal vapor source in order to deposit a third oxide and that by using a carbide as the metal vapor source, which may be vaporized by electron beam, there is an additional advantage of forming carbon-containing precipitates which reduce thermal conductivity.

However, as the Examiner has acknowledged that “the Rigney Patent (‘038) does not disclose dissociating a metal atom from a carbide compound…but simply vaporizing a carbide to deposit carbide precipitates,” the prior art of record does not provide any expectation that a metal and carbon could be dissociated from a metal carbide, the former oxidized and the latter forming a gas, free carbon, or a carbide, so that an oxide of the metal and a carbon-containing gas, elemental carbon, or a carbide are co-deposited in a coating. Therefore, one skilled in the art would not be motivated to modify the process of the Rigney Patent on the basis of the Rigney Application, because the Rigney Patent does not disclose that, at any time during the evaporation and deposition process, metal is available to be oxidized as a result of dissociation of the carbide compound.

Furthermore, the Rigney Patent discloses evaporating a carbide

compound to deposit precipitates of the carbide compound, and clearly does not teach nor even desires the thermodynamic conditions (sufficient oxygen within the vapor cloud) required to intentionally oxidize the metal of the carbide compound. Stated another way, it would be contrary to the intent of the Rigney Patent to provide an oxygen level in excess of that required to simply reform the TBC material dissociated during evaporation, because doing so would be counterproductive to the very thing the Rigney patent desires to deposit: carbide precipitates. Therefore, the prior art lacks any suggestion or desire to carry out the process being claimed by Appellants, and the only motivation of record for Appellants' claimed invention is Appellants' own teachings.

Finally, the problem solved by Appellants - the difficulty of depositing some combinations of oxides - is completely different from that solved by the Rigney Application and Patent, and there is no other basis of record for motivating one skilled in the art to further modify the teachings of the Rigney Patent for the purpose of solving this problem by carrying out Appellants' dissociation and oxidation processes. Instead, the motivation for such additional processes is found entirely within Appellants' specification.

For the above reasons, Appellants respectfully request that this Honorable Board of Appeals reverse the Examiner's rejection of claims 1-11 and 33 under 35 USC §103.

(3) Rejection of Claims 12-20 and 34 based on the Rigney Application and the Rigney Patent

Appellants' invention recited in independent claim 12 and its dependent claims 13-20 and 34 was also concluded to be obvious in view of the combined teachings of the Rigney Application and Rigney Patent. However, neither of these references teaches the deposition of a carbon-containing gas or elemental carbon, as required by independent claim 12.

> the ceramic coating comprising yttria-stabilized zirconia, the oxide formed by oxidation of ytterbium, neodymium, and/or lanthanum present as a result of dissociation of the carbide compound, and a uniform distribution of at least one of elemental carbon and CO. (Emphasis added.)

The coating of the Rigney Application is disclosed as containing only metal oxides, and the coating of the Rigney Patent is disclosed as containing only metal oxides and carbide and/or nitride precipitates. Appellants therefore also

respectfully request that this Honorable Board of Appeals reverse the Examiner's rejection of claims 12-20 and 34 under 35 USC §103.

CLOSING

For all of the reasons set forth above, Appellants respectfully request that this Honorable Board of Appeals reverse the Examiner's rejection of claims 1-20, 33 and 34 under 35 USC §103.

Respectfully submitted,

Domenica N.S. Hartman

Domenica N.S. Hartman
Reg. No. 32,701

August 8, 2008
Hartman & Hartman, P.C.
Valparaiso, Indiana 46383
TEL.# (219) 462-4999
FAX# (219) 464-1166

Attachments: Claims Appendix; Evidence Appendix; Related Proceedings Appendix

Claim Appendix

Claim 1: A process of depositing a ceramic coating on a surface, the ceramic coating comprising multiple different oxide compounds and an oxide of a metal, the process comprising the steps of:

using at least one evaporation source to provide the oxide compounds and a carbide compound comprising carbon and the metal; and

evaporating the at least one evaporation source in the presence of oxygen to dissociate the metal from the carbide compound, oxidize the metal, and produce a vapor cloud that contacts and condenses on the surface to form the ceramic coating, the ceramic coating comprising the oxide compounds, the oxide of the metal dissociated from the carbide compound, and at least one of elemental carbon, a carbon-containing gas, and precipitates of the carbide compound.

Claim 2: A process according to claim 1, wherein the oxide of the metal has a vapor pressure that is at least an order of magnitude different than the vapor pressure of at least one of the oxide compounds.

Claim 3: A process according to claim 1, wherein the carbide compound is at least one of YbC_2, NdC_2, and LaC_2, whereby the oxide of the metal is at least one of Yb_2O_3, Nd_2O_3, and La_2O_3.

Claim 4: A process according to claim 1, wherein the oxide compounds are yttria and zirconia and are present in the evaporation source as yttria-stabilized zirconia.

Claim 5: A process according to claim 4, wherein the carbide compound has a vapor pressure within one order of magnitude of the vapor pressure of zirconia.

Claim 6: A process according to claim 1, wherein the at least one evaporation source comprises two evaporation sources, the oxide compounds are present within a first of the evaporation sources, and the carbide compound is present within a second of the evaporation sources.

Claim 7: A process according to claim 6, wherein the first

evaporation source consists of the oxide compounds and the second evaporation source consists of the carbide compound.

Claim 8: A process according to claim 1, wherein the at least one evaporation source consists of a single evaporation source, and the oxide compounds and the carbide compound are present within the single evaporation source.

Claim 9: A process according to claim 1, wherein the ceramic coating consists of the oxide compounds, the oxide of the metal of the carbide compound, and at least one of the carbide compound and the carbon-containing gas.

Claim 10: A process according to claim 1, wherein the vapor cloud initially condenses on the surface so that the carbide compound is present in the ceramic coating, and the carbide compound is then reacted in situ to form the oxide of the metal of the carbide compound and the carbon-containing gas.

Claim 11: A process according to claim 1, wherein the carbon-containing gas is chosen from the group consisting of carbon dioxide and carbon monoxide.

Claim 12: A process of depositing a thermal barrier coating on a surface of a gas turbine engine component, the thermal barrier coating comprising yttria-stabilized zirconia and an oxide of a metal chosen from the group consisting of ytterbium, neodymium, lanthanum, and combinations thereof, the process comprising the steps of:

placing the component in a coating chamber containing at least one ingot that provides zirconia, yttria, and a carbide compound of the metal;

projecting a high-energy beam on the at least one ingot in the presence of oxygen to melt the at least one ingot, dissociate the metal from the carbide compound, oxidize the metal, and form a vapor cloud; and

allowing the vapor cloud to contact and condense on the component to form the ceramic coating, the ceramic coating comprising yttria-stabilized zirconia, the oxide formed by oxidation of ytterbium, neodymium, and/or lanthanum present as a result of dissociation of the carbide compound, and a

uniform distribution of at least one of elemental carbon and CO.

Claim 13: A process according to claim 12, wherein yttria and zirconia are present in the at least one ingot as yttria-stabilized zirconia.

Claim 14: A process according to claim 13, wherein the carbide compound has a vapor pressure within one order of magnitude of the vapor pressure of zirconia.

Claim 15: A process according to claim 12, wherein the at least one ingot comprises two ingots, yttria and zirconia are present within a first of the ingots, and the carbide compound is present within a second of the ingots.

Claim 16: A process according to claim 15, wherein the first ingot consists of yttria-stabilized zirconia and the second ingot consists of the carbide compound.

Claim 17: A process according to claim 12, wherein the at least one

ingot consists of a single ingot that consists essentially of zirconia, yttria, and the carbide compound.

Claim 18: A process according to claim 12, wherein the ceramic coating consists of yttria-stabilized zirconia, one of Yb_2O_3, Nd_2O_3, and La_2O_3, and at least one of CO and CO_2.

Claim 19: A process according to claim 12, wherein the vapor cloud initially condenses on the component so that the carbide compound is present in the ceramic coating, and the carbide compound is then reacted in situ to form the oxide and at least one of the elemental carbon and CO.

Claim 20: A process according to claim 12, wherein the thermal barrier coating has a microstructure of columnar grains.

Claims 21 through 32 (Canceled)

Claim 33: A process according to claim 1, wherein the oxygen is

present during the evaporating step in excess of that necessary to ensure the deposition of the oxide compounds.

Claim 34: A process according to claim 12, wherein the oxygen is present during the projecting step in excess of that necessary to ensure the deposition of yttria-stabilized zirconia.

Evidence Appendix

None.

Related Proceedings Appendix

None.